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Added salt and cancer mortality: confounding by smoking

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PM_{2.5} Species Importance of Accurate Measurement

To the Editor:

Why do different air pollution studies find conflicting results for the same pollutants? Holliday et al¹ illustrate the importance of accurate exposure, showing that more accurate exposure for PM₁₀ produced stronger estimates of health associations (although with larger standard deviations). Accurate exposure measurement is even more important for PM_{2.5} species—notably black carbon, which has higher local spatial variability than PM₁₀ or PM_{2.5}.

Using personally monitored measures of elemental carbon, PM_{2.5}, and sulfate concentrations in Atlanta, Suh and Zanobetti² found that elemental carbon (but not other pollutants) was strongly associated with 5 measures of heart rate variability. When centrally monitored data were substituted for personally monitored concentrations, the elemental carbon associations became considerably smaller and statistically consistent with a null effect.

Hsu et al³ found no associations of PM_{2.5} nickel with pulse rate in New York City when using centrally monitored measurements of airborne PM_{2.5} nickel as a proxy for personal exposure. However, when exposure was measured inside or just outside the home, or measured personally, associations were found.

Grahame⁴ examined whether the association of black carbon with heart rate variability was lower in studies using centrally monitored black carbon across wide geographic areas than in studies using more accurate proxy measures. The associations were most robust when subject exposure was reasonably accurate

and weakened with worsening exposure error—even suggesting the possibility that, when exposure was most poorly characterized, associations might shift from black carbon to pollutants with less exposure error (a finding needing further confirmation). Subsequently, Suh and Zanobetti² confirmed the reduction of heart rate variability associations when central monitor readings are a proxy for reasonably accurate exposure. These studies strongly suggest the importance of accurate assessment of exposure when studying the health effects of PM_{2.3} compounds and black carbon, in particular.

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Added Salt and Cancer Mortality

Confounding by Smoking

To the Editor:

High consumption of salt may increase the risk of cancer.¹ However, it is unclear whether personal variations in salt usage can affect cancer

risk. Adding salt to food before or after tasting increases salt consumption. This behavior could be an acquired taste or habit or the result of a decreased salt perception.² We compared cancer mortality among people who never, occasionally, or always added salt to their prepared meals. Smokers and people with obesity may have altered taste perception, and both characteristics may have a synergistic impact on eating behavior.³ We therefore included these variables in our analyses.

We analyzed data from 17,733 Swiss men and women 16 years and older who participated in the National Research Program 1A (NRP1A: 1977–79), a community health promotion initiative, or the Swiss MONICA (Monitoring of Trends and Determinants in Cardiovascular Disease: 1984–93) population survey, part of an international WHO project. We obtained mortality follow-up information by anonymously linking these data with the Swiss National Cohort, which encompasses all residents of Switzerland enumerated in the national 1990 or 2000 census, as well as data from death and emigration registries through the end of 2008. Linkage success was 94% (NRP1A) and 97% (MONICA).^{4,5}

Information on smoking (never, former, current smoker, with number of cigarettes) and salt habits (never, occasionally, or always adding salt to prepared meals) was obtained with questionnaires at baseline. Body mass index (BMI) was calculated from measured height and weight. Cancer death (n = 1,355) was defined according to the *International Classification of Diseases* (ICD: 8th revision until 1994 and 10th revision since 1995): ICD-8: 140–239; ICD-10: C00–C99; D00–D48. Cox proportional hazards regression models were calculated.

Those who reported that they always added salt to meals had a 30% (95% confidence interval = 4–62%) higher cancer mortality risk than those who never added salt (Table). People who occasionally added salt also tended to have an increased risk, suggesting dose dependence. Adjustment

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TABLE. Associations of Salt Habits with Cancer Deaths in 17,733 Men and Women ≥ 16 Years of Age

	Basic Model ^a RR (95% CI)	Basic Model + Smoking ^b RR (95% CI)	Basic Model + BMI ^c RR (95% CI)	Basic Model + Smoking + BMI ^d RR (95% CI)
Adding salt to prepared meals				
Never	1.00	1.00	1.00	1.00
Occasionally	1.12 (0.99–1.27)	1.07 (0.95–1.21)	1.14 (1.00–1.28)	1.09 (0.96–1.23)
Always	1.30 (1.04–1.62)	1.16 (0.93–1.45)	1.31 (1.05–1.63)	1.17 (0.94–1.47)

^aAdjusted for age, sex, and study wave.
^bAdditionally adjusted for smoking (never, former, and number of cigarettes).
^cAdditionally adjusted for BMI.
^dAdjusted for all variables.

for smoking substantially weakened this association, while adjustment for BMI had virtually no impact.

In this general population sample from Switzerland, there was a dose-response association between adding salt to a prepared meal and the risk of death from cancer. To some extent, this association was confounded by smoking. People who smoke may have a higher taste threshold than those who do not.² Smokers may also differ in their health behavior patterns, including less attention to a healthy diet.⁶ Both salt sensitivity and eating patterns could also vary between normal weight and overweight people,³ although BMI did not appear to confound the salt-mortality association in our data. Our analysis was limited by the fact that salt habits and smoking were self-reported and assessed only once, at baseline. In addition, cancer-specific analyses were not possible due to relatively small number of cancer deaths.

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Mobile Phones and Cancer

Next Steps

To the Editor:

Samet and colleagues¹ present the state of knowledge on mobile phones and cancer 2 years after the International

Agency for Research on Cancer evaluation of radiofrequency radiation,² which recommended a coordinated, strategic plan of epidemiologic research, experimental studies, and risk communication and management.

Samet and colleagues¹ describe results of recent epidemiologic studies, including analysis of data from 5 INTERPHONE countries using estimates of cumulative energy at tumor location.³ They report the increased glioma risk among heaviest users but omit important findings: a dose-response for glioma among long-term users and, in case-only analyses minimizing recall bias by ignoring reported amount and laterality of use, an increased odds ratio (OR) among long-term users in the most exposed part of the brain.³ They also do not mention a similar OR in case-specular analyses of data from 7 other INTERPHONE countries.⁴

Recommendations stemming from previous case-control studies include the following: (1) further development of radiofrequency radiation exposure modeling, (2) bias modeling, and (3) parallel reanalysis of the INTERPHONE and Hardell studies. We fully support such recommendations. Despite limitations of the case-control design—which must be addressed—this design is the most powerful for investigating potential associations between radiofrequency radiation and brain tumors.

Prospective studies based on operator records are also recommended; although immune to recall bias, they are limited by statistical power (INTERPHONE captured a population of 50 million, hardly achievable in a cohort study), exposure assessment, and selection bias. Time-trend analyses are important for population surveillance but have limited power to detect risks of tumors arising only in the most exposed part of the brain, years after substantial exposure.²

Samet and colleagues¹ also note the importance of developing and implementing a strategic research agenda and keeping the public well informed. The newly European Union-funded GERoNiMO project (geronimo.crealradiation.com) builds upon existing European resources (including large-scale

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